Wave Oscillations

SHM	$\ddot{x}+\omega_0^2 x=0$, $\omega_0=2\pi f_0=\sqrt{\frac{k}{m}}$
	$E=E_P+E_K, \frac{dE}{dt}=0$
Damped	$\ddot{x}+2\gamma\dot{x}+\omega_0^2 x=0, \gamma=\frac{b}{2m}, \omega^2=\omega_0^2-\gamma^2$
	$\Rightarrow x=Ae^{(-\gamma\pm i\omega)t}$ (b is damping constant)
	Light $\omega_0^2>\gamma^2$, Heavy $\omega_0^2<\gamma^2$, Crit $\omega_0^2=\gamma^2$
	$E=E_0 e^{-2\gamma t}, \tau=\frac{1}{2\gamma}, Q=\frac{\omega_0}{2\gamma}=\frac{\omega_0}{\Delta\omega}$
Super-position	$A(t)=\cos(\omega_1 t)+\cos(\omega_2 t)$
	$=2(\cos(t\frac{\omega_1+\omega_2}{2})\cos(t\frac{\omega_2-\omega_1}{2}))$

Electrostatics

Force / Field	$\underline{F}=\frac{Qq}{4\pi\varepsilon_0 r^2}, \underline{E}=\frac{F}{q}=\frac{Q}{4\pi\varepsilon_0 r^2}$
Potential Δ	$dV=\frac{dU}{q}=-\underline{E}.d\underline{l}, V=-\int_{\underline{\infty}}^{r}\underline{E}.d\underline{l}$
Gauss	$\phi_E=\int_S \underline{E}.d\underline{A}=\frac{Q}{\varepsilon_0}$
Conductors	$\underline{E}$ = $\underline{0}$ everywhere All charge on outer surface No net charge in inner surface
Capacitance	$C=\frac{Q}{V}=4\pi\varepsilon_0 R=\frac{\varepsilon_0 A}{d}$
	$U_E=\frac{1}{2}CV^2=\frac{1}{2}\varepsilon_0 E^2 V$

Magnetostatics

Force	$\underline{F}=q(\underline{E}+\underline{v}\wedge\underline{B})$, motor effect = RH
Ampere's	$\int_C \underline{B}.d\underline{l}=\mu_0 I \Rightarrow B=\frac{\mu_0 I}{2\pi r}$ (infinite wire)
Flux	$\phi_m=\int_S \underline{B}.d\underline{A}$ (closed surface = 0)
Inductor	$V_E=\int_C \underline{E}.d\underline{l}=-\frac{d\phi_m}{dt}, L=\frac{\phi_{threading}}{I}$
	$U_B=\frac{1}{2}LI^2=\frac{1}{2}\frac{B^2}{\mu_0}V$

Electrical Circuits

Complex	$Z_C=\frac{1}{i\omega C}$, $Z_L=i\omega L$
Oddments	$V_{RMS}=\frac{V_0}{\sqrt{2}}$, $\omega_0=\frac{1}{\sqrt{LC}}$

Waves

Basics	$k=\frac{2\pi}{\lambda}$, $c=\lambda\nu$, $\psi=A\cos(\omega t+kx)$
	$\psi=A\cos(\omega t+kx)$, $\frac{\partial^2\psi}{\partial x^2}=\frac{1}{c^2}(\frac{\partial^2\psi}{dt^2})$
String	$C=\sqrt{\frac{T}{\rho}}$, $E_{density}=\frac{1}{2}\rho(\frac{\partial\psi}{\partial t})^2+\frac{1}{2}T(\frac{\partial\psi}{\partial x})^2$
Standing	$\psi=A\cos(k_x x)\cos(\omega t)$
EM Waves	$\int_C \underline{B}.d\underline{l}=\mu_0\varepsilon_0\frac{d\phi_E}{dt}$, $c=\frac{1}{\sqrt{\varepsilon_0\mu_0}}$

Optics

Tiny Slit	$A=2A_0\cos^2(k(\frac{d}{2})\sin\theta)\cos(\omega t-kr)$
Finite Slit	$A=A_{\max}\sin c(\frac{\phi}{2})$
Two Slits	$A=A_{\max}\sin c(ka\sin(\frac{\phi}{2}))\cos(k\frac{d}{2})\sin\phi$
Refraction	$\frac{\sin\theta_1}{\sin\theta_2}=\frac{n_2}{n_1}$, TIR for sin > 1
Lenses	$\frac{1}{u}+\frac{1}{v}=\frac{1}{f}=(\frac{n_2}{n_1}-1)(\frac{1}{R_1}+\frac{1}{R_2}), P=\frac{1}{f}$

Wave-Particle Duality

Basics	$\lambda=\frac{h}{p}, E=h\nu$
Photoelectric	$K_{MAX}=h\nu-W=h(\nu-\nu_0)$
Compton	$\lambda'-\lambda=\frac{h}{m_e c}(1-\cos\theta)$
Evidence	Davidson-Germer (electron scattering from crystallised surface showed diffraction) G.P. Thompson (electrons on metal foil shows diffraction rings)